

SECTION 26 32 00 - GENERATOR ASSEMBLIES

PART I - GENERAL

1.1 SUMMARY

- A. A diesel powered engine generator set shall be provided as the required emergency power source for each new building that is 25,000 square feet or larger.
- B. The engine generator set shall provide three-phase power to all code-required electrical devices and systems including egress lighting. In addition, it shall provide power to all equipment and systems that are essential to basic building functionality as well as others deemed to be critical service. These include:
 - 1. Sump Pumps
 - 2. Ejector pumps
 - 3. Perimeter heating system pumps (where applicable).
 - 4. DDC Control system
 - 5. HW heating pumps
 - 6. Control air compressors
 - 7. Sewage pumps
 - 8. Card Access (if not backed-up by a battery system).
 - 9. Security System (If not backed-up by a battery system).
 - 10. Elevator cab lighting
- C. The elevator starting current requirements shall be included in the design of the emergency power system to allow the emergency generator adequate starting capacity to operate the elevator upon transfer. *[Note to AE: Contact F&S Engineering Services to determine if elevator is required to be connected to the emergency generator].*

1.2 RELATED DOCUMENTS

- A. *Section 23 13 23 – Fuel Storage Tanks.* Emergency Generator Tanks are considered storage tanks, and must comply with the requirements stated in *Section 23 13 23, NFPA 30 and NFPA 110, Standard for Emergency and Standby Power Systems.*

1.3 PERMITS

- A. A permit certified by the Office of the State Fire Marshal is required to be granted prior to the use or testing of the emergency generator.
- B. Provide an EPA permit for the generator assembly when required.

1.4 PROTOTYPE TESTS AND EVALUATION

- A. Prototype tests shall have been performed on a complete and functional unit. Component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110 for level 1 systems.

1.5 SUBMITTALS

- A. Emergency generator load calculations shall be submitted to verify that the loads associated with the equipment, devices and systems listed in this Section will be powered upon transfer.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. CAT
- B. Cummins
- C. Kohler

2.2 DIESEL ENGINE-GENERATOR SET

- A. The generator set shall be provided with integral mounted frame tank, automatic transfer switch, complete instrumentation, vandal resistant enclosure where applicable, and block and jacket heaters. The prime mover shall be diesel powered. Underground fuel storage tanks are not allowed for engine/generator sets. The storage tank shall meet the specifications of the State Fire Marshal. The regulation is: Title 41, Illinois Administrative Code Part 160, "Storage, Transportation, Sale, and Use of Gasoline and Volatile Oils". Tanks shall be frame mounted, of double wall U.L. listed construction. Tanks shall be sized large enough to support a 24 hour operation period. Tanks shall be equipped with sight glass and fuel spill protection.
- B. Remote Fuel Fill: A remote fuel fill station shall be provided. It shall incorporate spill containment and a fuel level gage. The associated piping shall be large enough to allow the tank to be filled at a generous fuel dispensing rate without fuel backing up.

2.3 PERFORMANCE

- A. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
- B. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
- C. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
- D. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

2.4 ENGINE

- A. The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
 - 1. An electronic governor system shall provide automatic isochronous frequency regulation.
 - 2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet.
 - 3. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per OSHA requirements.
 - 4. An electric starter(s) capable of three complete cranking cycles without overheating.
 - 5. Positive displacement, mechanical, full pressure, lubrication oil pump.
 - 6. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

7. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element.
8. Replaceable dry element air cleaner with restriction indicator. Flexible supply and return fuel lines.
9. Engine mounted battery charging alternator, 45 ampere minimum, and solid-state voltage regulator.

2.5 AC GENERATOR

- A. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. Two embedded RTD per phase and temperature indication equipment shall be provided.

2.6 ENGINE-GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The control shall be UL508 listed, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Standard 801.2, 801.3., and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.
- D. The generator set mounted control shall include the following features and functions:
 1. Three position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 2. Red "mushroom-head" push-button EMERGENCY STOP switch. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
 3. Push-button RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 4. Push-button PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically

be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

5. Generator Set AC Output Metering: The generator set shall be provided with a metering set including the following features and functions:
 - a. 2.5-inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
 - b. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
6. Generator Set Alarm and Status Message Display:
 - a. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions.
 - b. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
 - 1) low oil pressure (alarm)
 - 2) low oil pressure (shutdown)
 - 3) oil pressure sender failure (alarm)
 - 4) low coolant temperature (alarm)
 - 5) high coolant temperature (alarm)
 - 6) high coolant temperature (shutdown)
 - 7) engine temperature sender failure (alarm)
 - 8) low coolant level (alarm or shutdown--selectable)
 - 9) fail to crank (shutdown)
 - 10) overcrank (shutdown)
 - 11) overspeed (shutdown)
 - 12) low DC voltage (alarm)
 - 13) high DC voltage (alarm)
 - 14) weak battery (alarm)
 - 15) low fuel-daytank (alarm)
 - 16) high AC voltage (shutdown)
 - 17) low AC voltage (shutdown)
 - 18) under frequency (shutdown)
 - 19) over current (warning)
 - 20) over current (shutdown)
 - 21) short circuit (shutdown)
 - 22) ground fault (alarm)(optional--when required by code or specified)

23) over load (alarm) emergency stop (shutdown)

- c. In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

7. Engine Status Monitoring:

- a. The following information shall be available from a digital status panel on the generator set control.
 - 1) engine oil pressure
 - 2) (psi or kPA) engine coolant temperature (degrees F or C)
 - 3) Both left and right bank temperature shall be indicated on V-block engines.
 - 4) engine oil temperature (degrees F or C)
 - 5) engine speed (rpm)
 - 6) number of hours of operation (hours)
 - 7) number of start attempts
 - 8) battery voltage (DC volts)
- b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

8. Control Functions:

- a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
- b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
- c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
- d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
- e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature that is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

9. Alternator Control Functions:

- a. The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control

buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

- b. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.
 - c. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
 - d. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
 - e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
 - f. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
 - g. When required by National Electrical Code or indicated on Project Drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay which will function correctly in system as installed.
10. Control Interfaces For Remote Monitoring:
- a. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
 - b. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
 - c. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
 - d. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - e. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

- f. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the Drawings.
- g. The remote monitor controller shall have Ethernet capability connection for remote monitoring and control.

2.7 BASE

- A. The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

2.8 GENERATOR SET AUXILIARY EQUIPMENT AND ACCESSORIES

A. Coolant Heater:

1. Engine-mounted, thermostatically-controlled coolant heater(s) shall be provided for each engine. Heater voltage shall be as shown on the Project Drawings.
2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
3. The coolant heater shall be provided with a 24V DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements.

- B. Vibration Isolators: Spring/pad type vibration isolators shall be provided. Quantity shall be as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

- C. Starting and Control Batteries: Starting battery bank, calcium/lead antimony type, 24 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.

- D. Exhaust Silencer(s): Exhaust muffler(s) shall be provided for each engine, size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

- E. Remote Annunciator: A 20-light LED remote alarm annunciator with horn shall be provided. It shall be located as shown on the Drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

- F. Battery Charger: A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for each engine-generator set. The charger may be located in an automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
1. Loss of AC power - red light
 2. Low battery voltage - red light
 3. High battery voltage - red light
 4. Power ON - green light (no relay contact)
 5. Analog DC voltmeter and ammeter, 12 hour equalize charge timer, AC and DC fuses shall also be provided on the charger.
- G. Outdoor Weather-Protective Housing: Generator set housing shall be provided. It shall be factory-assembled to generator set base and radiator cowling. Housing shall provide ample airflow for generator set operation at rated load in the ambient conditions previously specified. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturer's standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
1. Primer thickness, 0.5-2.0 mils. Topcoat thickness, 0.8-1.2 mils.
 2. Gloss, per ASTM D523-89, 80% plus or minus 5%.
 3. Gloss retention after one year shall exceed 50%.
 4. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
 5. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
 6. Salt Spray, per ASTM B117-90, 1000+ hours.
 7. Humidity, per ASTM D2247-92, 1000+ hours.
 8. Water Soak, per ASTM D2247-92, 1000+ hours.
 9. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- H. Outdoor Weather-Protective Sound Attenuating Housing (If Required):
1. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of (As specified by the engineer) dab at any location 7 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
 2. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

3. The enclosure shall be provided with an exhaust silencer that is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.
4. All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.
5. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts is not acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

I. Fuel Day Tank (Indoor Gen-sets with remote fuel tank):

1. A fuel day tank with 50 gallon capacity shall be provided for each generator set. Day tank shall be equipped for automatic unattended operation. The fuel transfer day tank shall be a standard product of the manufacturer of the engine-generator set. The tank shall be UL listed, made of aluminized steel with welded construction, and pressure tested to 3 PSI. The day tank shall incorporate an integral fuel pump and motor; 1/4 HP, 120/240 Volt, 1-phase, 2 GPM with 20 foot lift. Provide a hand operated pump to bypass the motor driven pump and valves, for emergency use.
2. The fuel day tank control shall be provided with On/Off/Emergency Run Switch, Test/Reset Switch, AC Circuit Breaker, DC Circuit Breaker, and Indicator lamps:
 - a. Ready (green) - AC supply & DC control power available.
 - b. High Fuel (red) - Latching fault, indicates fuel level near overflow, shuts down pump, and closes N/O dry contacts.
 - c. Low Fuel (red) - Latching fault, indicates pump failure or operating float switch failure, Closes N/O dry contacts.
 - d. Low Fuel Shutdown (red) - Latching fault, indicates near empty tank, closes N/O contacts, which may be used to shutdown generator set to avoid air in the injection system.
 - e. Overflow to basin (red) - Latching fault, indicates fuel in overflow/rupture basin, shuts down pump, closes N/O dry contacts.
 - f. Spare (red) - with N/O and N/C dry contacts Pump Running (green)
3. Contacts shall be rated not less than 2 amps at 30VDC and 0.5 amps at 120VAC. Provide an overflow/rupture basin for the day tank with a minimum capacity of 150% of the daytank volume. Include an overflow alarm to indicate fuel in the basin

J. Fuel Storage Tank: A dual wall sub-base fuel storage tank shall be provided. It shall be large enough to support a 24 hour run time. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The tank shall be equipped with spill fill protection around the fueling cap. The equipment, as installed, shall meet all local and regional requirements for above ground tanks. The fill vents shall be raised 6 inches above the tank surface. The fuel gauge shall be mounted inside the housing. Externally mounted fuel gauges are not acceptable.

K. Fire Extinguisher and Cabinet: A fire extinguisher with a minimum rating of 4A60BC must be installed in an exterior fire extinguisher cabinet in the immediate vicinity of each generator installation in accordance with IL OSFM regulations. The extinguisher must be one from the approved manufacturers listed in Section 10 44 00 of these Facilities Standards.

2.9 TRANSFER SWITCH EQUIPMENT

A. Complete factory assembled transfer equipment shall be provided. It shall incorporate electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.

B. Transfer Switch Ratings:

1. Refer to the Project Drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosures, and accessories.
2. All transfer switches and accessories shall be UL listed and labeled, tested per UL Standard 1008, and CSA Approved. Transfer switches used for fire pump applications shall be specifically listed for that service, per NFPA20.
3. Main contacts shall be rated for 600 Volts AC minimum.
4. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure, in ambient temperatures of 40 to +50 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
5. Transfer switch equipment shall have a withstand and closing rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the Drawings. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third-party listed and labeled for use with the specific protective device(s) installed in the application.

C. Construction:

1. Transfer switches shall be double throw, electrically and mechanically interlocked, and mechanically held in both positions.
2. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms suitable for safe manual operation under load. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.
3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent interphase flashover. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
4. Transfer switches designated on the Drawings as 4 poles shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using add on accessory overlapping contacts are not acceptable.
5. Transfer switches that are designated on the Drawings as 3-pole shall be provided with a neutral bus and lugs, sized to carry 100% of the current designated on the switch rating
6. Enclosures shall be UL listed. The enclosure shall provide NEC wire bend space. The cabinet door shall be lockable by means of a key. Controls on cabinet door shall be key-operated.
7. Transfer switches shall be mounted in enclosures as designated on the Drawings. Separate enclosures shall be the NEMA type specified. The cabinet shall provide required wire bend space at point of entry as shown on the Drawings. Manual operating handles and all control switches (other than key operated switches) shall be accessible to authorized personnel only by opening the key locking cabinet door. Transfer switches with manual operating handles and/or non-key operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

- D. Automatic Controls: Transfer switches that are designated on the Drawing as automatic shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.

1. Control shall be solid state and designed for a high level of immunity to power line surges and transients, demonstrated by test to IEEE Standard 587 1980. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs.
2. Solid state undervoltage sensors shall simultaneously monitor all phases of both sources. Pickup and drop out settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase. Voltage sensors shall have field calibration of actual supply voltage to nominal system voltage.
3. Optional: Controls shall be provided with solid state overvoltage sensors, adjustable from 100 to 130% of nominal, to monitor all phases. Provide adjustable time delay of 0.5 to 2.2 sec.
4. Optional: Controls shall be provided with a solid state over and under frequency sensor to monitor the source(s). Pickup bandwidth shall be adjustable from a minimum of +/- 4% to a maximum of +/- 20% of nominal frequency. Dropout shall be +/- 5% of nominal wider than pickup frequency bandwidth. Adjustable time delay shall be from 0.1 to 15 sec. Automatic controls shall signal the engine-generator set to start upon signal from normal source sensors. Solid-state time delay start, adjustable from 0 to 5 seconds (factory set at 2 seconds) shall avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts factory wired to a field wiring terminal block.
5. A phase sequence monitor and balance module shall be provided to protect against inadvertent phase rotation hookup and monitor for voltage phase imbalance between phases.
6. The switch shall transfer when the emergency source reaches the set point voltage and frequency. Provide a solid-state time delay on transfer, adjustable from 0 to 120 seconds.
7. The switch shall retransfer the load to the normal source after a time delay retransfer, adjustable from 0 to 30 minutes. Retransfer time delay shall be immediately bypassed if the emergency power source fails.
8. Controls shall signal the engine generator set to stop after a time delay, adjustable from 0 to 10 minutes, beginning on return to the normal source.
9. Power for transfer operation shall be from the source to which the load is being transferred.
10. The control shall include latching diagnostic indicators to pinpoint the last successful step in the sequence of control functions, and to indicate the present status of the control functions in real time, as follows:
 - a. Source 1 OK
 - b. Start Gen Set
 - c. Source 2 OK
 - d. Transfer Timing
 - e. Transfer Complete
 - f. Retransfer Timing
 - g. Retransfer Complete Timing for Stop
11. The control shall include remote transfer inhibit and area protection features.
12. Transfer switches shall be equipped with field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch

operating speed control feature shall have an adjustable range of 0 to 7.5 seconds. Phase angle monitor is not an acceptable substitute for this feature.

E. Front Panel Devices:

1. A key-operated selector switch shall be mounted on the cabinet front. It shall provide the following positions and functions:
 - a. Test - Simulates normal power loss to control for testing of generator set. Controls shall provide for a test with or without load transfer.
 - b. Normal - Normal operating position.
 - c. Retransfer - Momentary position to override retransfer time delay and cause immediate return to normal source, if available.
2. A key-operated switch with standby and normal positions to manually switch between the standby and normal source shall be provided.
3. Lamps that indicate transfer switch position and source availability shall be provided.

F. Non-automatic Controls:

1. Transfer switches designated on the Drawings as Non-Automatic shall be provided with a non-automatic control. The control shall operate the transfer switch position either by a remote contact opening or closing, or by a front panel mounted selector switch. The selector switch shall be a three position switch. In the center Auto position the transfer switch shall transfer and retransfer in response to input signals as shown. The key shall be removable with the selector switch in the Auto position only. Turning the selector switch to the Emergency position shall transfer load to an energized emergency power source. Turning the selector switch to the Normal position shall transfer load to an energized normal power source.

G. Accessory Items: Transfer switches shall be equipped with accessories as follows:

1. Transfer switches that are designated on the Drawing as automatic shall be provided with a fully automatic control system, and provisions for manual operation as described in this section.
2. Meters: Provide an AC Voltmeter, an Ammeter, and a Frequency meter; 2.5 inch, analog, 2% accuracy. Provide a phase selector switch to read L-to-L voltage and current of both power sources.
3. Exerciser Clock: Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.
4. Battery Charger: Provide a float charge battery charger rated 10 amps. DC output voltage shall be as required for the starting batteries. An ammeter shall display charging current. The battery charger shall have fused AC input and fused DC output. Include fault indications and Form C contact for AC Fail, High Battery Voltage, and Low Battery Voltage.
5. Manual Selector Switch: Provide a manual/automatic retransfer selector switch to provide either automatic retransfer after the retransfer time delay, or a manual retransfer when selected by an operator.
6. Load Shed: Provide a load shed relay, to move the transfer switch from the emergency position to a neutral position, on receipt of a signal from a remote device.
7. Signal Module: Provide signal module, to delay the transfer and retransfer of the switch for up to 50 seconds to provide a pretransfer warning signal contact. Provide signals for the following conditions:
 - a. Source 1 available

- b. Source 2 available
- c. Test/exercise
- d. Backup source available
- e. Contacts for these functions are to be form C type, rated for 120 VAC or 30 VDC at 4 amps.

PART 3 - EXECUTION

3.1

END OF SECTION **26** 32 00

This section of the *U of I Facilities Standards* establishes minimum requirements only.
It should not be used as a complete specification.